ORIGINAL RESEARCH

THE LATERAL SCAPULAR SLIDE TEST: A RELIABILITY STUDY OF MALES WITH AND WITHOUT SHOULDER PATHOLOGY

Thomas Curtis, DSc, PT[a]
James R. Roush, PT, PhD, ATC[b]

ABSTRACT

Background. Abnormal scapular movement or malposition is related to shoulder pathology. The lateral scapular slide test (LSST) is used to determine scapular position with the arm abducted in three positions.

Objective. The purpose of this study was to test the reliability of the LSST using a scoliometer.

Methods. Thirty-three male subjects (18 to 34 years) participated in this study. Group one (n=15) had shoulder pathology; Group two (n=18) did not have pathology. A test-retest, repeated measures design, with three experienced raters and the three positions of the LSST, was used to test the reliability of the LSST. All measurements in each position were taken bilaterally.

Results. Pearson Correlations for Position 1 and 2 ranged from .78 to .92 whereas position 3 ranged from .62 to .81. The ICC (2,2) ranged from .87 to .95 for positions 1 and 2. ICC (2,2) ranged from .70 to .82 for positions 3. Overall ICC (2,3) ranged from .83 to .96. The coefficients of determination ranged from .38 to .89. The SEM ranged from 3.00 to 8.26 mm, with the largest error found in position 3.

Discussion and Conclusion. The LSST can be reliable in screening scapular position. Although a large range of error exists in measurements as indicated by the standard error of the measurement, the LSST provides more objective measures than pure observation.

Key Words: scapula, shoulder, measurement.

[a]Rocky Mountain University of Health Sciences
Provo, Utah

[b]A.T. Still University
Arizona School of Health Sciences
Mesa, Arizona

INTRODUCTION

Orthopedic clinicians frequently evaluate and provide therapeutic intervention for shoulder dysfunction. A very important link in shoulder function, the scapula merits special attention. The functional role of the scapula is often misunderstood by clinicians, and this lack of awareness can result in incomplete evaluation and diagnosis of impairment of the shoulder.[1,2] Consequently, scapular rehabilitation is often ignored.[3-5]

Most authors consider the assessment of scapular positioning on the thoracic cage to be part of a comprehensive evaluation of patients with suspected shoulder dysfunction.[6-8] Restricted scapulohumeral motion may lead directly to rotator cuff impingement and an eventual partial or full-thickness tear of the rotator cuff tendons.[7,9,10] Observing the scapulothoracic rhythm is necessary because disruption to this movement may lead to dysfunction.[3,6,7,10-12]

Kibler[1,4] described a test to clinically measure static scapular positions called the lateral scapular slide test (LSST). This test involves measuring the distance from the inferior angle of the scapula to the nearest vertebral spinous process using a tape measure or goniometer in three positions: shoulder in neutral, shoulder at 40-45 degrees of coronal plane abduction with hands resting on hips, and the shoulder at 90 degrees abduction with the arms in full internal rotation. Kibler[1,4] contends that the injured or deficient side would exhibit a greater scapular distance than the uninjured or normal side and asserted that a bilateral difference of 1.5 cm (15 mm) should be the threshold for deciding whether scapular asymmetry is present. Kibler[1] also suggested that the LSST may be used to monitor the scapular stabilizer muscles in any rehabilitative program that involves shoulder strengthening exercises. Inferences drawn by Kibler[1] about scapular symmetry and shoulder pathology are based largely on unpublished work and most of his data collection is performed with overhead throwing athletes.

Several researchers determined that the LSST measurements may be too variable and, thus, unreliable to be useful.[7,13-15] However, T'Jonck et al[16] concluded that the LSST technique holds promise for further studies, has the advantage of measuring in three positions, and with some familiarization can be reliable.

The purpose of this study was to determine the reliability of the LSST and its error between raters using a scoliometer. A scoliometer similar to the one used in the present study has shown high reliability and moderate validity to detect scoliosis.[17,18] Since the scoliometer has been shown to be a simple and reliable tool in detecting scoliosis, the present study extended its use to measure scapular position.

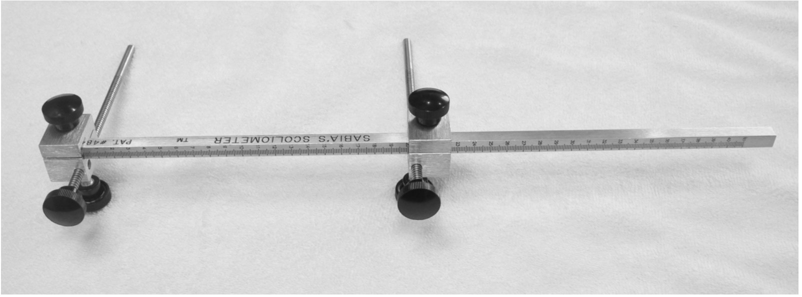

Figure 1. Scoliometer used in data collection that had been machined tooled to allow measurement data to the nearest millimeter.

METHODS

Subjects

Thirty-three volunteer subjects were recruited from the Phoenix, Arizona metropolitan area. Subjects were males ranging in age from 18 to 34 years (mean = 25.5; SD = 5.69). Eighteen of the subjects reported no shoulder pain, injury, or history of dysfunction. Fifteen of the subjects reported diagnoses of unilateral or bilateral shoulder pathology or injury. Diagnoses included tendonitis/strain (6), impingement (3), acromioclavicular separation (3), clavicle fracture (2), and dislocation (1). Diagnoses of injury were made before inclusion of all subjects in the study. These diagnoses were self-reported by the subject following examination by a physician. Exclusion criteria included systemic disease that affects neuromuscular function, the inability to maintain at least 90 degrees of bilateral coronal plane shoulder abduction, existence of any observed postural or bony deformities regardless of physician's diagnosis, or any existing medical diagnosis prohibiting the subject from participating in the study.

Figure 2. Test position 1 standing in dependent position.

Equipment

A scoliometer (Dr. Sabia's Scoliometer, Red Bank, NJ), marked in millimeters, was used in this study to measure the linear scapular distances. A scoliometer can be described as a caliper attached to two movable points as shown in *Figure 1*. Amendt et al[17] found high intrarater and interrater reliability (r = .86 - .97) using the scoliometer in detecting scoliosis. Amendt et al[17] also determined the validity of the scoliometer compared to x-ray and reported correlation coefficients between .32 and .46. Interrater reliability ranged from .81 - .82 in a different study by Murrell et al.[18]

Examiners

Three physical therapists, employed within a separate private practice setting, administered the LSST to the subjects. The three therapists averaged 22.67 years of experience (SD = 2.52), predominantly in an orthopedic practice setting. All raters were experienced in using the LSST, but were not familiar with the scoliometer.

Data Collection

Prior to data collection, each evaluating therapist participated in a session to discuss the purpose of the study, as well as the inclusion and exclusion criteria of the subjects. Each therapist was then individually trained in the measurement procedure by the primary investigator, including written and verbal instructions for evaluating the subject, appropriate standing postures, and appropriate positioning of the shoulder in the three test positions. The evaluating therapist practiced the procedure until he/she felt sufficiently competent and comfortable with the measurement tool and procedures.

The Institutional Review Board (IRB) of Rocky Mountain University of Health Sciences approved this study as safe for human subjects. All subjects participating in this study were required to read and sign an informed consent agreement before any participation in this study. Subjects were asked to complete brief, self-reported medical history. Subjects with and without pathologies participated in this study, but the evaluating therapist/raters did not have knowledge of the subjects' medical histories.

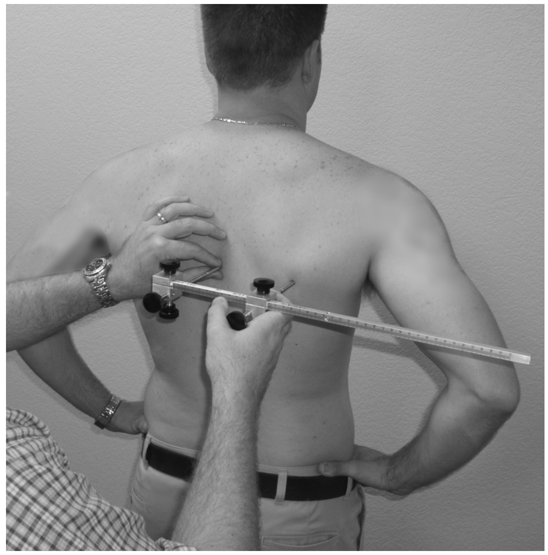

Figure 3. Test position 2 with arms resting on hips with thumbs posterior.

The subject was then instructed to assume the first test position of the LSST with the shoulders in neutral position *(Figure 2)*. Using the scoliometer, each therapist measured the distance between the inferior angle of the scapula and the closest thoracic spinous process in the first test position. The therapist then locked the knobs of the scoliometer to assure that the caliper was fixed. The scoliometer was then handed to the primary investigator, who silently read and recorded the measures. The scoliometer was then reset to zero and the therapist repeated this procedure a second time. An average of the two readings was used for data analysis. This process was repeated on the right and left sides. The first therapist then exited and the second therapist entered the room and immediately applied the scoliometer in the same fashion as the previous therapist with the subject. This same procedure was followed by the third therapist. After each therapist measured each subject in the first test position, the procedures were repeated for the second test position *(Figure 3)*; hands resting on hips with thumbs posterior.

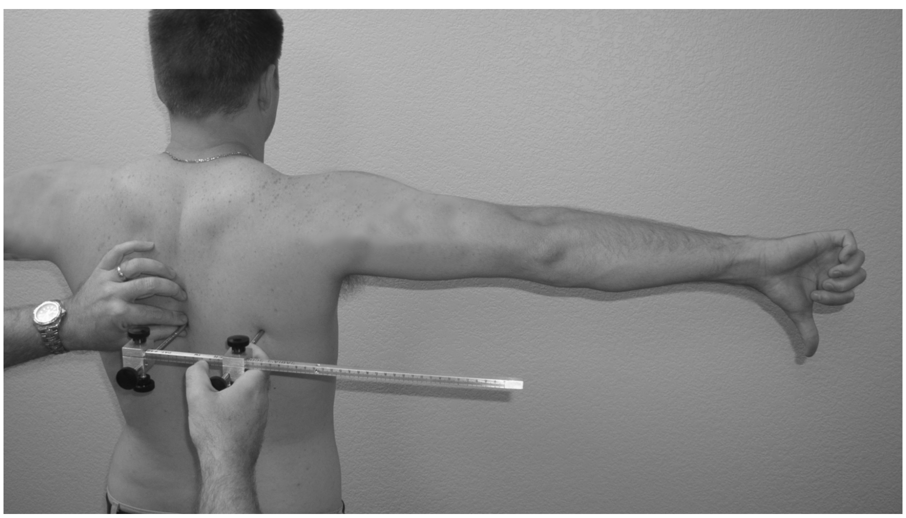

Figure 4. Test position 3 with arms abducted 90 degrees with full shoulder internal rotation.

The third test position required the subject to maintain a posture of approximately 90 degrees of shoulder abduction, full shoulder internal rotation, and full radioulnar supination *(Figure 4)*. This movement was difficult for some subjects. Therefore, the subjects were allowed to return to the first test position after each evaluating therapist completed his series of measurements in the third test position. Before the subsequent evaluating therapist obtained their measures, the subject was instructed to return to the third test position. The subjects were not allowed to change their standing posture. Upon completion of the series of scoliometer measurements in each of the subsequent test positions by the evaluating therapist, the subject was then excused and the process was repeated with the next subject. The therapists were also unaware of any of their measurements, nor those of the other evaluators. All measurements were determined consecutively from position 1 to position 3 and bilaterally.

Data Analysis

Pearson correlation coefficients were calculated to determine the relationships between measures. When determining the relationship between the two sets of variables, Domholdt[19] described terminology about the strength of the relationships. A correlation of .90 to 1.00 was described as a very high relationship; whereas a correlation of .70 to .89 was described as a high relationship. A correlation of .50 to .69 was described as a moderate relationship and a correlation of .26 to .49 was described as a low relationship. However, a correlation of .00 to .25 was indicative of little, if any, relationship.

In addition, coefficients of determination were calculated to determine the shared variability between measures for the three therapists. This coefficient is an indication of the proportion or percentage of variance between two variables. A coefficient of determination of 50% or more is considered good.[19]

In addition, standard errors of the measurement (SEM) were calculated to determine the amount of error between the therapists. The SEM, as a measure of absolute reliability and the standard deviation of measurement error, can be an estimate of how much a score varies between raters for repeated measures.

Finally, to determine the agreement between the therapists, an intraclass correlation coefficient (ICC) was calculated, using models ICC (2,2) and ICC (2,3). All statistical calculations were performed using the Statview statistical package (SAS, Cary, NC).

Table 1. Correlation coefficients (r), coefficient of determination (r^2), intraclass correlation coefficients (ICC), and standard error of the measurements (SEM) between the three raters for the subjects without pathology.

Rater	Position	r *	r^2	ICC (2,2)	SEM**
1 vs. 2	One	.92	.85	.94	5.21
1 vs. 3	One	.91	.83	.95	5.58
2 vs. 3	One	.92	.85	.95	4.80
1 vs. 2	Two	.82	.67	.87	6.37
1 vs. 3	Two	.80	.64	.87	7.16
2 vs. 3	Two	.92	.85	.96	4.38
1 vs. 2	Three	.66	.44	.77	7.54
1 vs. 3	Three	.64	.41	.75	8.26
2 vs. 3	Three	.81	.66	.77	6.22

*All correlations were significant at an alpha level of .05
**SEM measured in mm

RESULTS

In the group of subjects without pathology, a very high relationship existed between raters for test position 1 and test position 2 *(Table 1)*. For test position 3, a moderate to high relationship existed. In the group of subjects with pathology, again, a very high relationship was found between raters for test position 1 and test position 2 *(Table 2)*. For test position 3, a moderate relationship existed as the coefficients ranged between .62 and .72. Although a strong relationship occurred and less error (as indicated by the coefficient of determination) with test positions 1 and 2 in subjects with and without shoulder pathology, less relationship and shared variability was found in test position 3.

When comparing the SEM with the threshold of 15 mm proposed by Kibler,[1] these coefficients were quite low, as found in Tables 1 and 2. For position 3 in both groups, the SEMs are less than the threshold of 15 mm, but are 50% of the threshold. This finding may be of some concern in that most of the measure to the threshold may be error.

Intraclass correlation coefficients (ICC), specifically an ICC (2,2) and ICC (2,3), were performed to determine the agreement between raters. Using an ICC (2,2), the agreement between raters for subjects without pathology and with pathology was considered good for position 1 and position 2. For position 3, the agreement was considered moderate to good for subjects without pathology and with pathology. The overall agreement between the three raters for subjects with and without pathology, using an ICC (2,3), was found to be good *(Table 3)*. The ICC (2,3) for all the test positions of both involved and noninvolved shoulder groups had demonstrated a strong degree of agreement, thus, demonstrating high interrater reliability.

DISCUSSION

Kibler[1,21] proposed that assessment of scapular symmetry is based on biomechanics and believed that muscle deficiencies are associated with an unstable scapula. Although a thorough understanding of shoulder girdle mechanics is important, the reliability of the LSST remains in question. Results of previous reliability studies of scapular positioning, as well as those presented in this article, have demonstrated that measurements of linear distance related to the scapula can be reliable.[12,22,23] The LSST has been used to assess scapular asymmetry, which may be indicative of shoulder dysfunction. Moreover, the LSST is a relatively simple procedure that is neither time intensive nor expensive. However, while some researchers have found the LSST to be reliable,[24,25] many researchers concluded the LSST may be too variable and, thus, unreliable.[7,12-14,26]

Using the ICC, good reliability appears to exist for using the LSST for test positions 1, 2, and 3 for subjects without pathology. For subjects with pathology, the reliability of test positions 1 and 2 would appear to be good; but for test position 3, the reliability would appear to be moderate to good. Test position 3 challenges scapular stability by abduction and internal rotation of the humerus at 90 degrees and closely approximating the humeral head against the coracoacromial hood. The scapular stabilizers, particularly the serratus anterior, are forced to contract and upwardly rotate the scapula to prevent impingement of suprahumeral structures. Thus, test position 3 challenges the muscular force couple and, therefore, one may see more variability with scapular positioning. While maintaining position 3, impingement of pain sensitive structures may occur, thus, increasing the variability of the measures.

Table 2. Correlation coefficients (r), coefficient of determination (r^2), intraclass correlation coefficients (ICC), and standard error of the measurements (SEM) between the three raters for the subjects with pathology.

Rater	Position	r *	r^2	ICC (2,2)	SEM**
1 vs. 2	One	.88	.77	.93	4.60
1 vs. 3	One	.87	.76	.91	4.76
2 vs. 3	One	.95	.89	.97	3.00
1 vs. 2	Two	.78	.61	.87	5.38
1 vs. 3	Two	.81	.66	.88	4.72
2 vs. 3	Two	.87	.76	.93	4.18
1 vs. 2	Three	.69	.48	.80	6.86
1 vs. 3	Three	.72	.52	.82	6.36
2 vs. 3	Three	.62	.38	.70	7.20

*All correlations were significant at an alpha level of .05
**SEM measured in mm

Kibler[1,4] has asserted that a bilateral difference of 1.5 cm (or 15 mm) should be the threshold for deciding whether scapular asymmetry is present. As stated previously, the SEM for subjects without pathology ranged between 4.80 mm and 5.58 mm for position 1, between 4.38 mm and 7.16 mm for position 2, and between 6.22 mm and 8.26 mm for position 3. Portney and Watkins[20] stated that the SEM can be used as an estimate of reliability, in that there is a 95% chance that the true mean score lies within a range of ± 2 SEM. For the SEM reported in this study, these ranges would be quite large. Therefore, while the relationships and agreement of the scores (as indicated with the Pearson Correlation Coefficients and ICC's) were quite high and would be indicative of high reliability, the true score for the LSST may be greater than the 1.5 cm asserted by Kibler.[1] Therefore, the threshold of 1.5 cm to be considered shoulder asymmetry needs further scrutiny.

Table 3. ICC (2,3) for an overall agreement between the raters for the three test positions and for the subjects with and without pathology.

Subjects without pathology		Subjects with pathology	
Position	ICC (2,3)	Position	ICC (2,3)
One	0.96	One	0.96
Two	0.93	Two	0.93
Three	0.83	Three	0.84

Odom et al[13] found that comparing the LSST between the two scapulae was unreliable and, thus, deduced the LSST to be invalid and unreliable. They used a simple measurement procedure using a string to determine the linear measurement, whereas a scoliometer was used in this study. They acknowledged the differences in measurement technique and clinical experience among raters might partially account for their findings. Problems with the tensile properties of string may have existed, which was not taken into consideration in the Odom et al[13] study and may have created significant intra and interrater variance.

A major difference in this study compared to Odom et al[13] was the experience of the raters. Odom et al[13] used six raters with an average of 5.8 years of experience. They felt this reflected the experience of a clinician in an outpatient orthopedic setting. The experience of the raters in this study averaged over 22 years. All of the raters in the study were familiar with the LSST, but were not familiar with the scoliometer. Using a scoliometer for measurement was an attempt to further provide objective measures. Perhaps by using a scoliometer, physical therapy students or novice physical therapists may be more reliable in measuring LSST.

Numerous investigators have been critical of 2-dimensional methods for scapular assessment.[2,7,15] Methods using 2-dimensional analysis do not assess the tipping or tilting of the scapula about an axis parallel to the scapular spine and winging of the scapula about a vertical axis.[27,28] However, many clinicians are forced to assess shoulder and scapular motion with 2-dimensional methods. Furthermore, practical assessment using 3-dimensional methods remains conjecture at best, due to expense, time, and availability. It is not known if 3-dimensional methods would provide more information to the clinician in developing a plan of care for the patient or client.

Several limitations existed in this study. The investigator could not control the educational background of the rater/therapist. Although subjects with shoulder pathology were included in the sample, the investigator did not control the type of pathology the subject presented nor the functional range of motion presented by the subject. However, it should be noted that the validity of LSST is based on its face validity compared to clinical observation of scapular asymmetry. The raters in this study, due to their clinical experience, were assumed to use very accurate visualization, palpation, and measurement skills of the inferior angle of the scapula and the adjacent thoracic spinous process. Still, the raters in this study all reported greater difficulty evaluating mesomorphic males due to muscle mass and adipose tissue, which may obscure the identification of anatomical landmarks. Because the raters were unaware of either their own measurements or those of the other raters, the results are not likely to have been influenced by bias.

CONCLUSIONS

The results of our investigation were that measurements obtained with the lateral scapular slide test (LSST) and a scoliometer are reliable in assessing scapular positioning or symmetry. However, a large range of error in measurements was found as indicated by the SEM, when to the parameters proposed by Kibler.[1] The parameter of 1.5 cm (15 mm) as an indicator of shoulder dysfunction should be further scrutinized. The authors believe the LSST provides more objective measures than pure observation and can be enhanced by using a scoliometer or caliper rather than a tape measure.

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CORRESPONDENCE

James R. Roush, PhD, PT, ATC
Physical Therapy Program
A.T. Still University
Arizona School of Health Sciences
5850 E. Still Circle
Mesa, Arizona 85206
(480) 219-6000
Fax: (480) 219-6100
email: jroush@atsu.edu